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RESEARCH ARTICLE

Dual effects of aliphatic carboxylic acids on cresolase and catecholase reactions of mushroom tyrosinase

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Abstract

Catecholase and cresolase activities of mushroom tyrosinase (MT) were studied in presence of some n-alkyl carboxylic acid derivatives. Catecholase activity of MT achieved its optimal activity in presence of 1.0, 1.25, 2.0, 2.2 and 3.2 mM of pyruvic acid, acrylic acid, propanoic acid, 2-oxo-butanoic acid, and 2-oxo-octanoic acid, respectively. Contrarily, the cresolase activity of MT was inhibited by all type of the above acids. Propanoic acid caused an uncompetitive mode of inhibition (K_i = 0.14 mM), however, the pyruvic, acrylic, 2-oxo-butanoic and 2-oxo-octanoic acids showed a competitive manner of inhibition with the inhibition constants (K_i) of 0.36, 0.6, 3.6 and 4.5 mM, respectively. So, it seems that, there is a physical difference in the docking of mono- and o-diphenols to the tyrosinase active site. This difference could be an essential determinant for the course of the catalytic cycle. Monophenols are proposed to bind only the oxyform of the tyrosinase. It is likely that the binding of acids occurs through their carboxylate group with one copper ion of the binuclear site. Thus, they could completely block the cresolase reaction, by preventing monophenol binding to the enzyme. From an allosteric point of view, n-alkyl acids may be involved in activation of MT catecholase reactions.

Keywords: *Mushroom tyrosinase; Aliphatic carboxylic acids; Catecholase activation; Cresolase inhibitionAbbreviations:*

Abbreviations: Mushroom Tyrosinase (MT); Inhibition constants (K_i); Agaricus bisporus (A. bisporus); 4-[(4-methylphenyl) azo]-phenol (MePAPh); 4-[(4-methylbenzo) azo]-1,2-benzenediol (MeBACat); Phosphate buffer solution (PBS); 3,4-Dihydroxyphenylalanine (DOPA)

Introduction

Tyrosinase (EC 1.14.18.1) catalyzes the oxidation of mono-, di-, and polyhydric phenols to o-quinones [1]. Quinones can polymerize non-enzymatically to melanin as the most important natural biopolymer responsible of pigmentation and the color and patterns of mammalian skin [2, 3].

The production of abnormal melanin pigmentation (melasma, freckles, ephelide, senile lentigines, etc.) is a serious esthetic problem in human beings [4]. In addition, tyrosinase is responsible for the undesired enzymatic browning of fruits and vegetables [5] that take place during senescence or damage at the time of post harvest handling, which makes the identification of novel tyrosinase inhibitors extremely important.

Various aromatic carboxylic acids are known potent inhibitors of tyrosinase [6–8]. Benzoic, isovanillic, cinnamic, p-coumaric, salicylic and 3-hydroxybenzoic acids inhibit the oxidation of catechol and the hydroxylation of tyramine catalyzed by cherimoya epicarp polyphenol oxidase [9]. Caffeic and ferulic acids activate the oxidation of catechol; protocatechuic and syringic acids activate the hydroxylation of tyramine [9]. Aromatic carboxylic acid inhibition on o-diphenol oxidase from sweet cherry fruits was reduced by esterification or by replacing the benzene ring with an aliphatic or heterocyclic group, but not by replacing it with a highly unsaturated open chain [10]. Study of phenylalkyl acids and alcohols, polyphenols, nitrophenols, esters, aldehydes, and ketones on catecholase activity showed carboxylic acids are stronger inhibitors than corresponding alcohols and aldehydes [7].

Aliphatic carboxylic acids do not affect cherimoya (A. cherimolia Mill) epicarp polyphenol oxidase activity [9].

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